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A NEW TAENIACANTHID COPEPOD FROM THE ESOPHAGUS OF A SEA URCHIN IN QUEENSLAND

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ABSTRACT

The cyclopoid copepod *Clavisodalis salmacidis* sp. nov., the fifth taeniacanthid to be reported from sea urchins, occurs in the esophagus of the temnopleurid *Salmacis belli* Döderlein in Queensland. The new species may be distinguished from its only congener by the female genital segment being about as long as wide, the caudal ramus separated from the anal segment, and the claw of the female maxilliped unguiform and recurved with two rows of spines on its attenuated tip, the claw of the male maxilliped terminating in a spinulose area.

Four taeniacanthid copepods have been described from Echinoidea. Humes and Cressey (1961) described three species from *Diadema setosum* (Leske) in Madagascar — *Echinosocius pectinatus, Echinosocius dentatus,* and *Echinirus laxatus.* Humes (1970) described *Clavisodalis heterocentroti* from *Heterocentrotus trigonarius* (Lamarck) at Eniwetok Atoll. In addition, Gooding (1965) found two more species of *Echinosocius* and another species of *Echinirus* living with *Diadema* at Singapore, but did not describe them. Other taeniacanthids occur on fishes.

The dissection of three Aristotle's lanterns of *Salmacis belli,* preserved in alcohol, revealed the copepods which are the subject of this paper. The copepods were found clinging by means of the second antennae to the lining of the esophagus.

MATERIALS AND METHODS

The copepods were cleared in lactic acid. Dissections were prepared using the method described by Humes and Gooding (1964).

The figures were drawn with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which it was drawn. The abbreviations used are: A_1 = first antenna, MD = mandible, P = paragnath, MX_1 = first maxilla, and P_{1-4} = legs 1–4.

Family TAENIACANTHIDAE Wilson, 1911
Genus **Clavisodalis** Humes, 1970

Clavisodalis salmacidis sp. nov.
(Figs. 1–42)

MATERIAL EXAMINED

HOLOTYPE: QM W7977, ♀, from oesophagus of *Salmacis belli* Döderlein, trawled in Moreton Bay, SE Queensland, by C. Boel, 25.v.1977.

PARATYPES: QM W7978, ♂, allotype, same data as holotype. QM W7979, 3 ♂, 5 ♀, QM W7980, 9 copepodids, same data as holotype. One ♂, 2 ♀, in the collection of the author (dissected).

DESCRIPTION

FEMALE: Body (Figs. 1, 2) elongate and moderately flattened, dorsoventral thickness of prosome about 0·47 mm. Length (not including setae on caudal rami) 2·07 mm (1·98–2·24 mm) and greatest width 0·68 mm (0·62–0·73 mm), based on four specimens in lactic acid. Segment of leg 2 almost completely fused with segment of leg 1; slight separation seen only in lateral view (Fig. 2). Anterior part of prosome guitar-shaped in dorsal view and wider than succeeding segments. Ratio of length to width of prosome 2·25:1. Ratio of length of prosome to that of urosome 2·34:1.

Segment of leg 5 (Fig. 3) 130 × 234 μm. Genital segment 260 μm long, in dorsal view expanded in its anterior half (width 263 μm) and with nearly parallel sides in its posterior half (width 164 μm). Genital areas situated laterally on expanded part. Each area (Fig. 4) with three smooth setae 75, 37, and 10 μm long. Three postgenital segments from anterior to posterior 101 × 148, 55 × 140, and 75 × 166 μm. Anal segment with lateroventral row of spinules on both sides (Fig. 6).

Caudal ramus (Figs. 5, 6) moderately elongate, 127 × 68 μm, ratio of length to width 1·87:1. Outer lateral seta 51 μm and dorsal seta 40 μm, both smooth. Outermost terminal seta 78 μm, innermost terminal seta 75 μm, and two median terminal setae 180 μm (outer) and 300 μm (inner), all with small lateral barbules. Ventral row of spinules near insertion of outermost terminal seta. Left caudal ramus of one female lacking dorsal seta and having extra row of spinules near outermost terminal seta (Fig. 7).

Body surface smooth with very few hairs (sensilla).

Egg sac (Figs. 1, 8, 9, 10) with 3–14 eggs, each about 170 μm in average diameter. Largest egg sac seen (Fig. 10) 0·74 × 0·40 mm, with 14 eggs.

Rostral area (Fig. 11) broad and projecting slightly anteriorly.

First antenna (Fig. 12) 323 μm long and 5-segmented. Lengths of segments (measured along their posterior nonsetiferous margins): 73 (143 μm along anterior margin), 75, 44, 35, and 26 μm respectively. Formula for armature: 19, 8, 4, 2 + 1 aesthete, and 7 + 1 aesthete. Many setae on first segment with short barbules; setae on segments 2–5 smooth.

Second antenna (Figs. 13, 14) 3-segmented, with formula 1, 1, 7 (terminally with three clawlike spines and three setae and subterminally with a very small seta). Seta on second segment with truncate, very finely denticulate tip. Third segment ornamented on its inner surface with spinules. Distal outer corner of segment produced to subacuminate point and bearing row of spinules and small setiform element. One of three terminal spines strongly recurved (Fig. 15).

Maxillary hook (Fig. 16) elongate and slender, 118 μm along shorter side, 156 μm along longer side.

Labrum (Fig. 17) with broadly rounded posteroventral margin bearing row of spines. Mandible (Fig. 18) terminally with stout unilaterally pectinate spine and adjacent small spiniform process. Paragnath (Fig. 17) a small smooth lobe. First maxilla (Fig. 19) with three setae. Second maxilla (Fig. 20) 2-segmented, second segment having terminally two stout spines with strong lateral spinules and one small naked seta. Maxilliped (Figs. 21, 22) 3-segmented. First segment elongate and unarmed. Second segment small and wedge-shaped. Third segment forming a recurved claw 125 μm long with prominent subterminal spinules and bearing proximally an antero-outer seta and two very small postero-inner setules. Arrangement of mouthparts as in Figure 23.

Ventral area between maxillipeds and first pair of legs without special sclerotization.

Leg 1 (Fig. 24) with both rami 2-segmented. Legs 2–4 (Figs. 26, 29, 30) with 3-segmented rami. Formula for armature (Roman numerals representing spines, Arabic numerals indicating setae) as follows:

P_1: coxa 0–0, basis 1–1, exp. I–0;8, enp 0–1;7.

P_2: coxa 0–0, basis 1–0, exp I–0;I–1;II,I,3, enp 0–1;0–1;I,I,3.

P_3: coxa 0–0, basis 1–0, exp I–0;I–1,I,1,I,2,1, enp 0–1;0–1,I,2.

P_4: coxa 0–0, basis 1–0, exp I–0;I–1;I,1,3,1, enp 0–1;0–1;1,3.

Legs 1 and 2 with intercoxal plates bilaterally armed with spines on free margin. Leg 1 (Fig. 24) with basis having strong spines along inner and inter-ramal margins; these inter-ramal spines absent in legs 2–4. Inner lobe of basis with barbed seta; this seta absent in legs 2–4. Second segment of exopod with eight setae as in Figure 25, but rarely with seven setae as in Figure 24. Leg 2 (Fig. 26) with outer spine on first segment of exopod bearing spines on posterior surface (Fig. 27). One female with both rami of leg 2 abnormal as shown in Figure 28. Leg 3 (Fig. 29) with outer side of third segment of exopod bearing I, 1, I. Leg 4 (Fig. 30) with hairs on outer margin of first and second segments of endopod.

Leg 5 (Fig. 31) 2-segmented. First segment approximately 52 × 47 μm, with seta 45 μm, and bearing ventrodistally a row of fine spinules. Second segment elongate, 114 × 44 μm, bearing four distal setae 39, 39, 127, and 88 μm, all minutely barbed. Row of very small spinules along distal end of segment.

Leg 6 probably represented by three setae on genital area (Fig. 4).

Color unknown.

MALE: Body (Fig. 32) resembling in general aspects that of female. Length (excluding setae on caudal rami) 1·50 mm (1·40–1·57 mm) and greatest width 0·58 mm (0·55–0·61 mm), based on seven specimens in lactic acid. Segment of leg 2 separated from segment of leg 1 by dorsal transverse suture. Ratio of length to width of prosome 1·58:1. Ratio of length of prosome to that of urosome 1·52:1.

Segment of leg 5 (Fig. 33) 86 × 213 μm. Genital segment 135 × 221 μm, subrectangular and wider than long. Genital areas located laterally near posterior margin of segment (Fig. 42). Three postgenital segments from anterior to posterior 114 × 164, 99 × 151, and 107 × 122 μm.

Caudal ramus (Fig. 33) similar to that of female, but smaller, 104 ×49 μm. One male with abnormal caudal rami (Fig. 34).

Body surface smooth, with very few sensilla as in female.

Rostral area, first antenna, second antenna, maxillary hook, labrum, mandible, paragnath, first maxilla, and second maxilla as in female. Maxilliped (Fig. 35) massive, 4-segmented. First segment short with one smooth seta. Large second segment swollen proximally, bearing on inner less swollen side two small setae and five prominent spines and other smaller spines as indicated. Small third segment unornamented. Fourth segment forming a stout, slightly recurved claw bearing four proximal setae, longest of them minutely barbed, and having on anterior surface a row of delicate spinules leading toward finely spinulose tip (Fig. 36).

Ventral area between maxillipeds and first pair of legs as in female.

Legs 1–4 segmented and armed as in female, with same spine and setal formula. Leg 1 (Fig. 37) with certain setae having several long proximal hairs, a few of these setae plumose rather than with short barbs. Leg 2 resembling female but terminal spine on exopod with blunt tip and naked throughout except for minute spinules near tip (Fig. 38), and endopod (Fig. 39) with outer hairs on second segment. Leg 3 similar to that of female, but terminal spine on exopod with blunt tip as in leg 2. Left endopod in one male with abnormal armature (Fig. 40), right endopod in this male normal. Leg 4 like that of female, but one male with abnormal endopods (Fig. 41).

Leg 5 (Fig. 42) resembling that of female. First segment 39 x 34 μm and second segment 91 x 36 μm.

No setae visible on genital area and leg 6 apparently absent.

Extruded spermatophore not seen.

Color unknown.

ETYMOLOGY: The specific name *salmacidis* is the genitive form of the generic name of the host, from Σαλμακις, a nymph who in the fountain of Caria embraced a youth named Hermaphroditus, and both grew together.

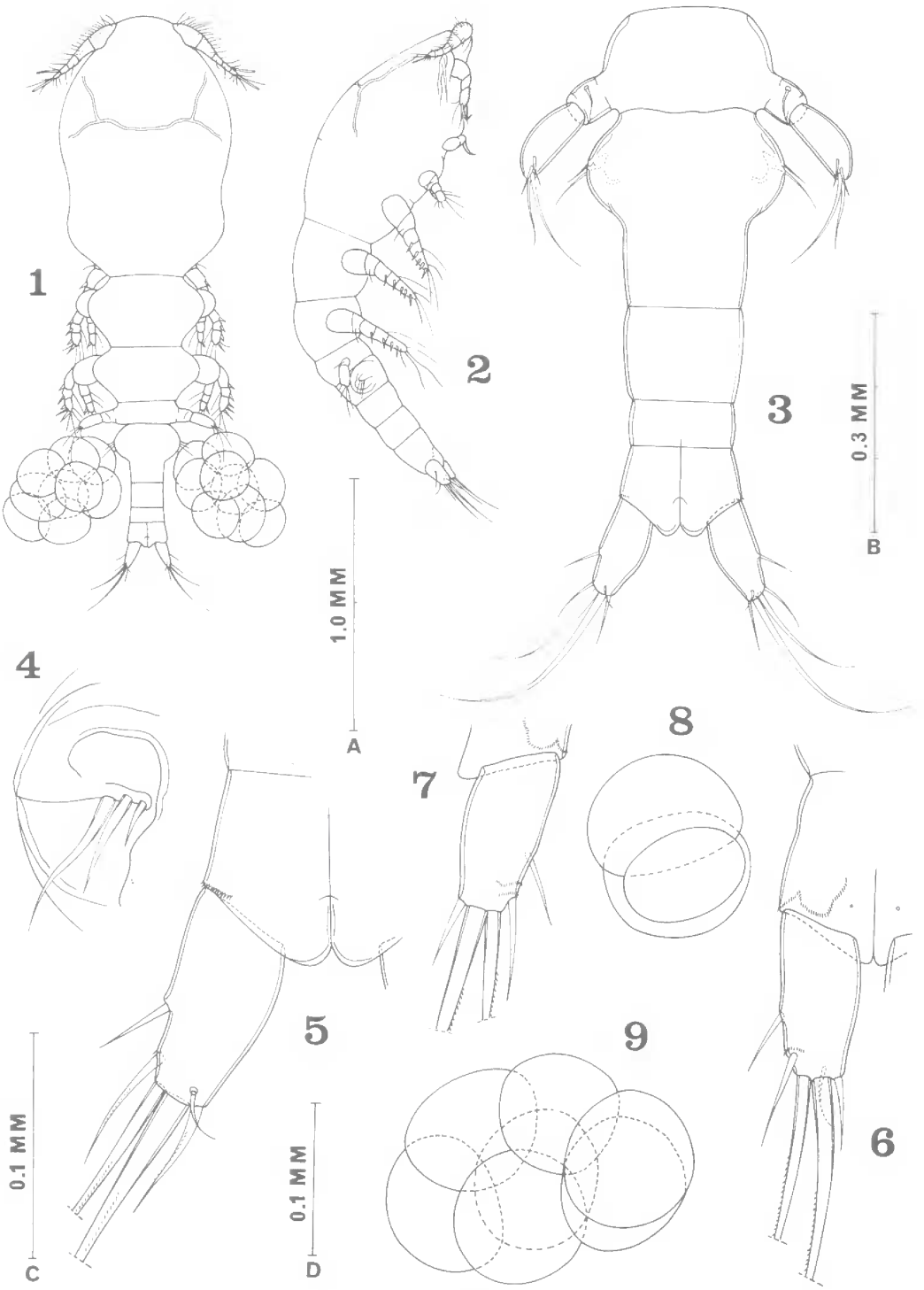
DISCUSSION

Clavisodalis salmacidis differs from *Clavisodalis heterocentroti* in several features easily seen without dissection in animals cleared in lactic acid. These selected characters are shown in Table 1.

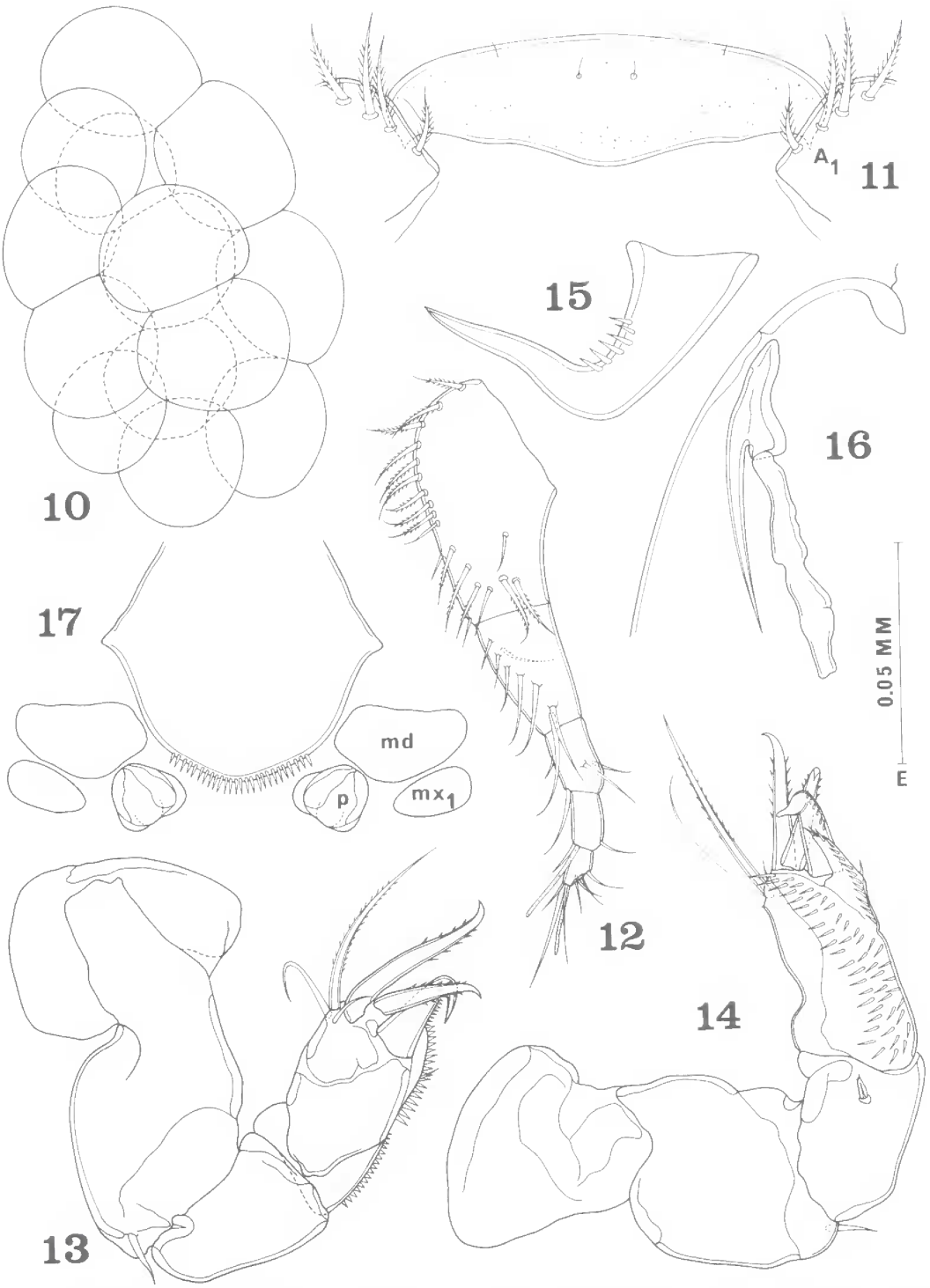
In both *C. heterocentroti* and *C. salmacidis* the armature of legs 1–4 is subject to variation. Most individuals, however, conform to the formula as indicated for the two species respectively. Accurate identification obviously requires observation of more than one copepod.

TABLE 1: CHARACTERS USEFUL FOR THE DIFFERENTIATION OF THE TWO SPECIES OF *CLAVISODALIS*.

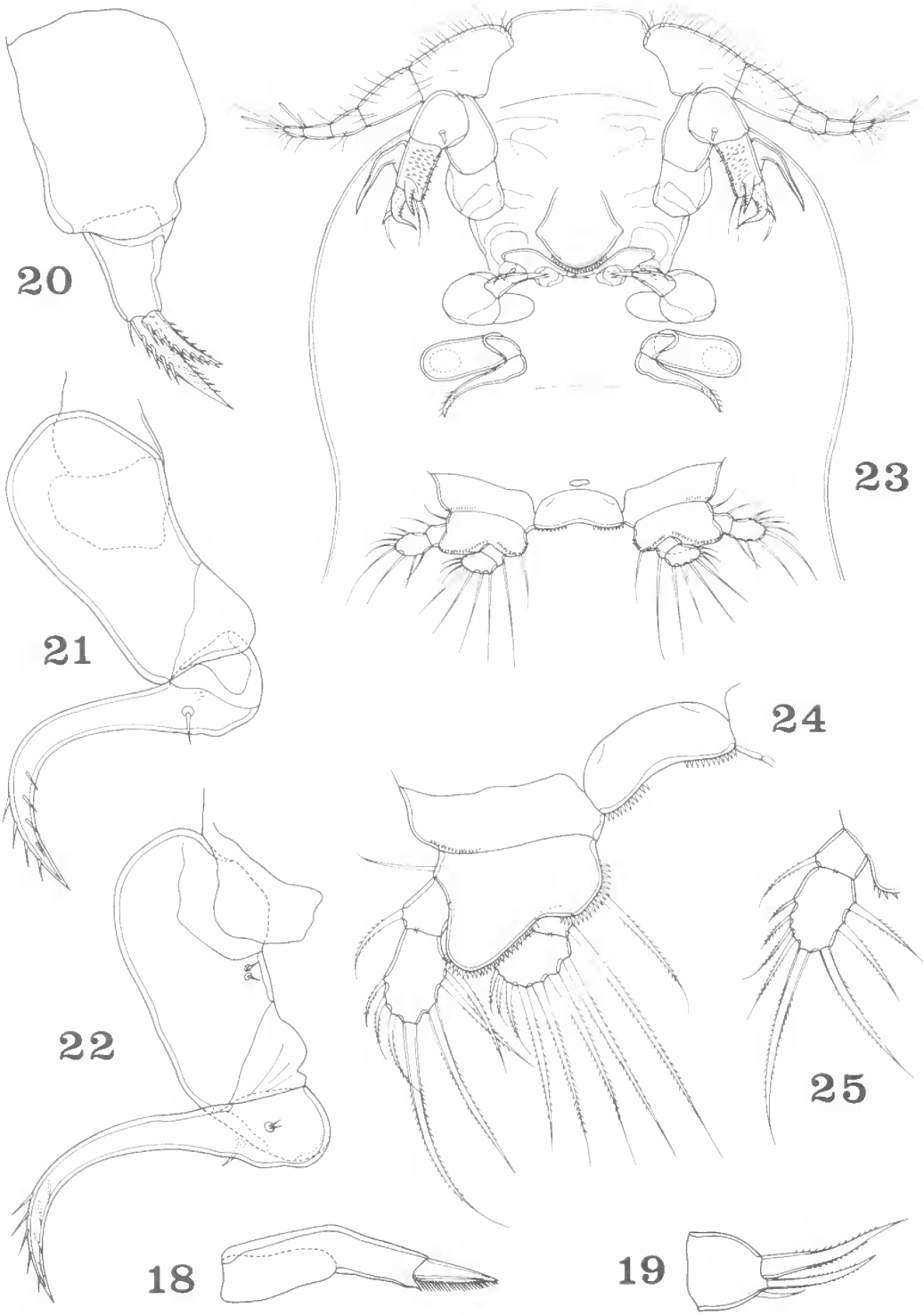
Character	*C. heterocentroti*	*C. salmacidis*
FEMALE		
genital segment	much wider than long	about as long as wide
caudal ramus	fused with anal segment	separated from anal segment
claw of maxilliped	clavate, not recurved, with cluster of spines on blunt tip	unguiform, recurved, with two rows of spines on attenuated tip
number of setae on second segment of P_1 Exp and Enp	7, 6	8, 7
armature of segments 1 and 2 of P_3 and P_4 Enp	0–0; 0–0	0–1; 0–1
armature of inner side of second segment of P_4 Exp	none	one seta
MALE		
claw of maxilliped	terminating in fine filament	tip with spinulose area



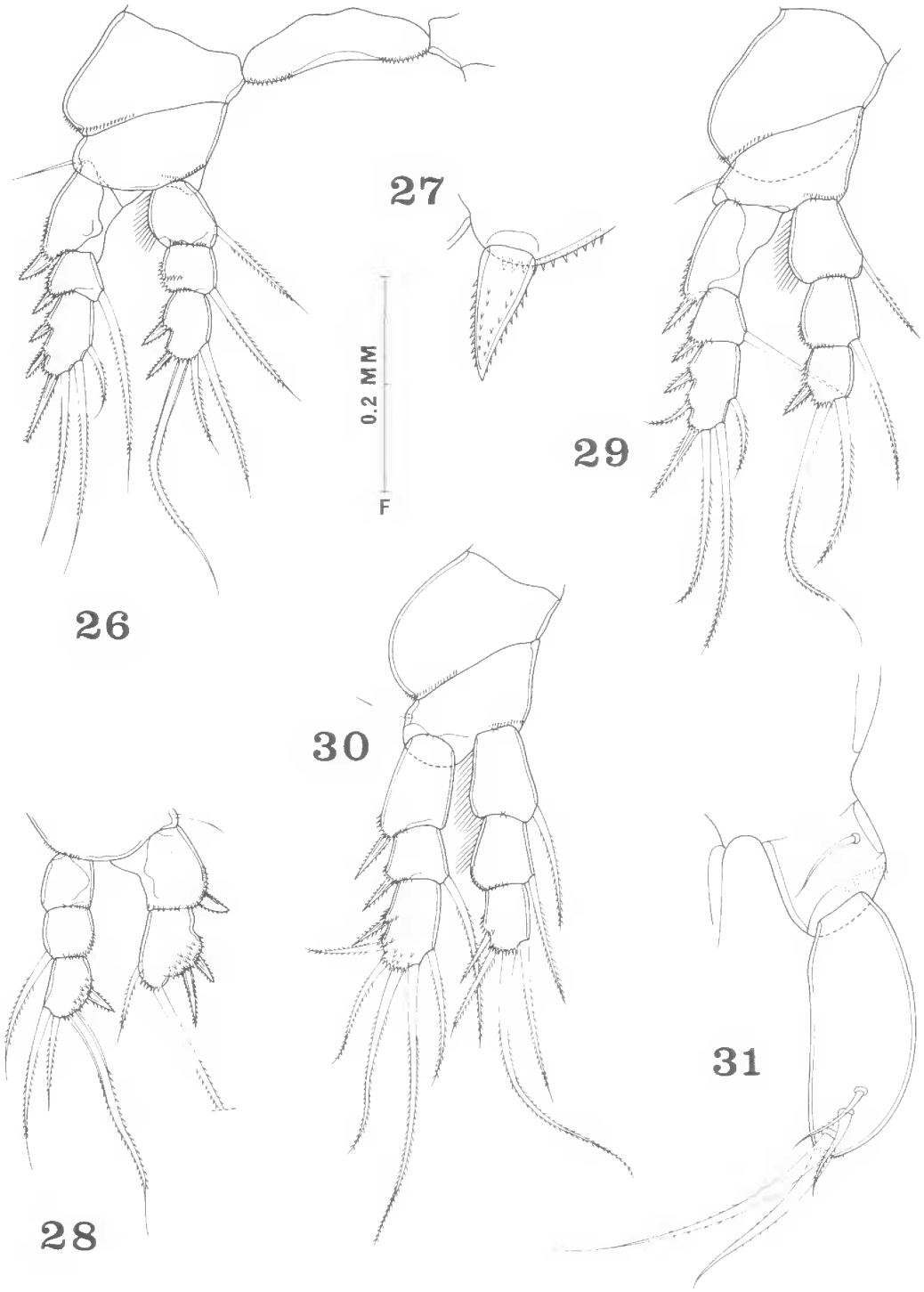
FIGS. 1–9: *Clavisodalis salmacidis* sp. nov., female. 1, dorsal (A); 2, lateral (A); 3, urosome, dorsal (B); 4, genital area, lateral (C); 5, caudal ramus, dorsal (D); 6, caudal ramus, ventral (D); 7, abnormal caudal ramus, ventral (D); 8, egg sac, ventral (B); 9, egg sac, ventral (B).



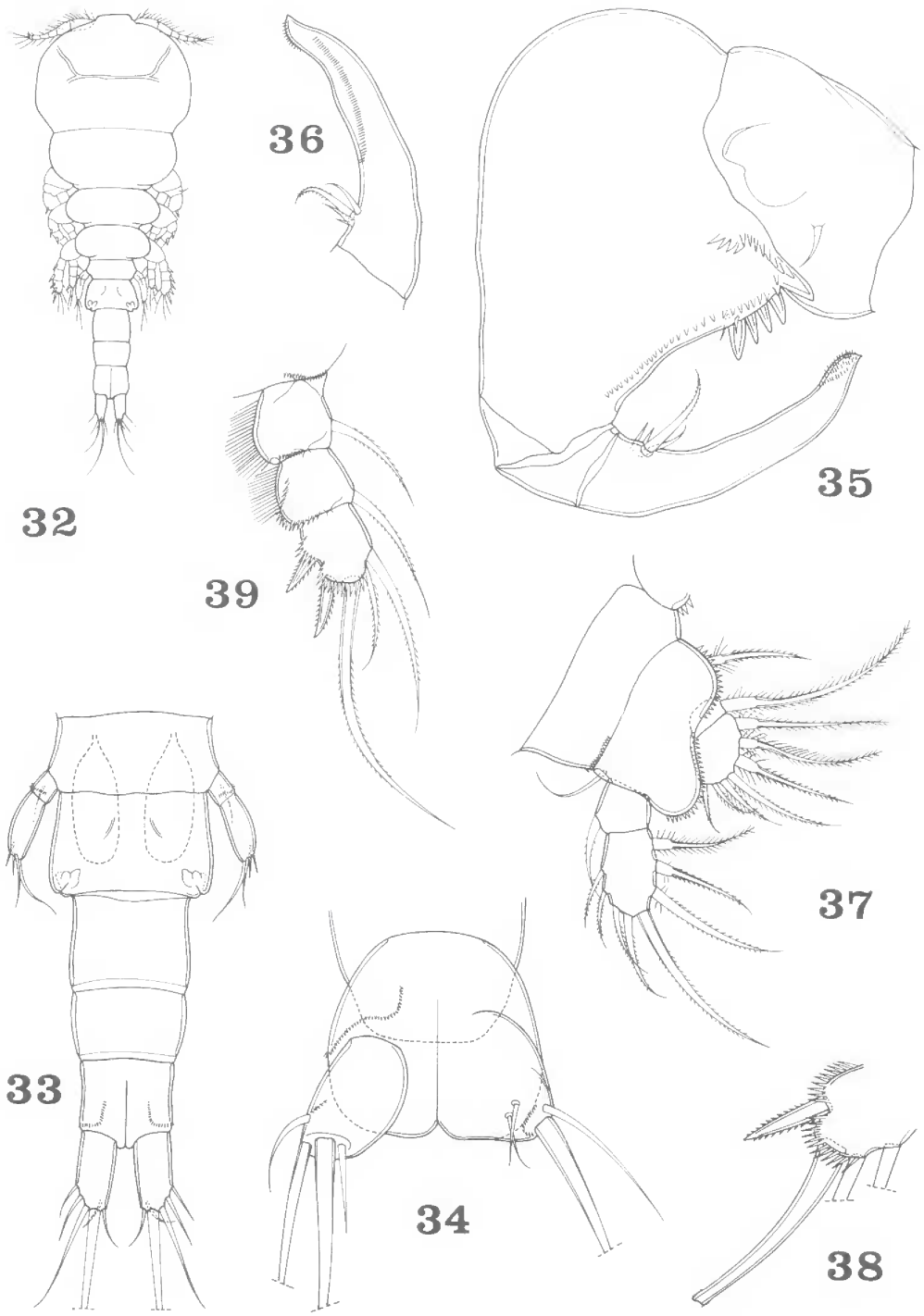
FIGS. 10–17: *Clavisodalis salmacidis* sp. nov., female. 10, egg, sac, ventral (B); 11, rostrum, ventral (C); 12, first antenna, ventral (D); 13, second antenna, outer (C); 14, second antenna, inner (C); 15, terminal spine on second antenna, posterior (E); 16, maxillary hook, ventral (D); 17, labrum and paragnaths, ventral (C).



FIGS. 18–25: *Clavisodalis salmacidis* sp. nov., female. 18, mandible, ventral (C); 19, first maxilla, postero-inner (C); 20, second maxilla, postero-inner (C); 21, maxilliped, antero-outer (C); 22, maxilliped, postero-inner (C); 23, cephalosome, ventral (B); 24, leg 1 and intercoxal plate, anterior (D); 25, exopod of leg 1, anterior (D).



FIGS. 26–31: *Clavisodalis salmacidis* sp. nov., female. 26, leg 2 and intercoxal plate, anterior (F); 27, outer spine on first segment of exopod of leg 2, posterior (E); 28, abnormal rami of leg 2, anterior (F); 29, leg 3, anterior (F); 30, leg 4, anterior (F); 31, leg 5, dorsal (C).



FIGS. 32–39: *Clavisodalis salmacidis* sp. nov., male. 32, dorsal (A); 33, urosome, ventral (B); 34, abnormal anal segment and caudal rami, ventral (D); 35, maxilliped, postero-inner (C); 36, claw of maxilliped, anterior (C); 37, leg 1, anterior (D); 38, terminal spine on exopod of leg 2, anterior (C); 39, endopod of leg 2, anterior (D).

The site of taeniacanthid copepods in sea urchins appears to be the esophagus. This is confirmed by the recovery of *C. salmacidis* from the esophagus and by information supplied by Gooding (personal communication to the author) that such copepods are commonly to be found at this site in tropical Pacific Echinoidea. When taeniacanthids were first discovered in 1955 in *Diadema* in Madagascar, they were obtained by washing the entire urchins in sea water with 5 per cent ethyl alcohol. This undoubtedly stimulated some of the copepods to crawl from the esophagus out of the mouth. They were subsequently recovered from the sediment resulting from the washing. Many more copepods could perhaps have been found if the esophagus of each urchin had been opened. Unfortunately, at that time it was not known that the real habitat of these copepods is the esophagus.

The range of the host urchin, *Salmacis belli,* extends throughout the East Indies and North Australia (Clark and Rowe 1971). At present *Clavisodalis salmacidis* is known only from southeastern Queensland. Whether the copepod follows the range of the host is not known.

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LITERATURE CITED

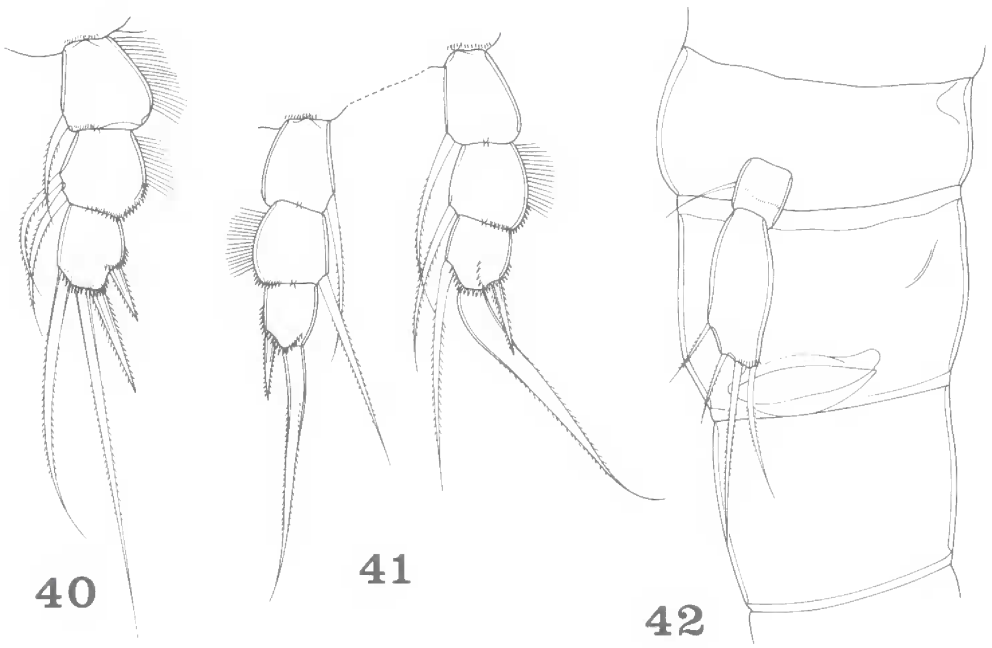
Clark, A.M. and Rowe, F.W.E., 1971. Monograph of shallow-water Indo-West Pacific echinoderms. Brit. Mus. (Nat. Hist.), publ 690, pp. 1–238.

Gooding, R.U. 1965. Taeniacanthid copepods associated with the black sea-urchin *Diadema setosum* in Madagascar and Singapore. *Med. J. Malaya* **20**: 176.

Humes, A.G. 1970. *Clavisodalis heterocentroti* gen. et sp. n., a cyclopoid copepod parasitic on an echinoid at Eniwetok Atoll. *J. Parasitol.* **56**: 575–83.

Humes, A.G. and Cressey, R.F., 1961. Copépodes taeniacanthides parasites d'un oursin à Madagascar. *Mem. Inst. Scient. Madagascar* 1959 (F) **3**: 1–12.

Humes, A.G. and Gooding, R.U., 1964. A method for studying the external anatomy of copepods. *Crustaceana* **6**: 238–40.



Figs. 40–42: *Clavisodalis salmacidis* sp. nov., male. 40, abnormal endopod of leg 3, anterior (D); 41, abnormal endopods of leg 4, anterior (D); 42, segment of leg 5, genital segment, and first postgenital segment, lateral (D).